

Cosumnoperla hypocrena, a new genus and species of western
Nearctic Isoperlinae (Plecoptera: Perlodidae)*

STANLEY W. SZCZYTKO AND RICHARD L. BOTTORFF

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Abstract.—*Cosumnoperla hypocrena*, a new genus and species of Isoperlinae is described from specimens of male, female, nymph and ova. The major diagnostic characters of this new genus include: 1. male 10th tergum with a broad, elevated, notched triangular process; 2. small bulbous male supra-anal process; 3. male vesicle absent; 4. male paraprocts reduced, flat and lightly sclerotized; 5. female subgenital plate large with a deep posteromedian notch; 6. ova oblong, collar and eclosion line absent; 7. nymphal mandibles with 6 teeth and lacinia bidentate; 8. adult and nymphal mesosternal Y-ridge attached to posterior ends of furcal pits, transverse ridge connecting anterior ends of furcal pits, and 9. gills absent. Based on these characters this genus is thought to be most closely related to *Calliperla* Banks. Isoperlinae now includes the endemic Nearctic genera *Calliperla*, *Cascadoperla* Szczytko and Stewart, *Clioperla* Needham and Claassen, and *Cosumnoperla*, the Holarctic genus *Isoperla* Banks, and the Palearctic genera *Kaszabia* Rauser and *Mesoperlina* Klapalek.

Isoperlinae is a small group of 6, mostly monotypic genera including Palearctic-Oriental endemics (*Mesoperlina* Klapalek and *Kaszabia* Rauser), Nearctic endemics (*Calliperla* Banks, *Cascadoperla* Szczytko and Stewart, and *Clioperla* Needham and Claassen), and the large Holarctic genus *Isoperla* Banks. *Rickera* Jewett and *Bulgaroperla* Rauser have recently been placed in Perlodinae (Szczytko and Stewart, 1984; Stark and Szczytko, 1984).

In the Nearctic and Palearctic Regions *Isoperla* contains the greatest diversity of Isoperlinae species with ca. 95% of the Nearctic and 91% of the Palearctic species. The number of *Isoperla* species in North America is divided into western and eastern faunal segments generally delineated by the eastern edge of the Rocky Mountains and the Great Plains. The eastern faunal segment is the most diverse with ca. 67% of the North American Isoperlinae species. The western genera *Calliperla* and *Cascadoperla* have fairly restricted distributions along the coastal range while the eastern *Clioperla* is widely distributed (Szczytko and Stewart, 1984).

Recently while R. L. Bottorff was studying the ecology of stoneflies in the Cosumnes River, El Dorado County California, a series of Isoperlinae were discovered which did not key to any known genus. Detailed study of the adults indicated that these specimens represented a new genus and species. This discovery parallels other recent finds of rare and unique stoneflies in similar habitats (eg. *Viehooperla* Stark and Stewart, 1982a; *Oconoperla* Stark and Stewart, 1982b).

MATERIALS AND METHODS

Illustrations of adult and nymphal structures were drawn using a Wild M8 stereo dissecting microscope equipped with lightfield-darkfield base and camera lucida. Nymphal mouthparts were drawn from scanning electron micrographs made using an ISI Super III SEM.

Male and female terminalia were treated for study according to the methods described by Szczytko and Stewart (1981). Aedeagal armature was studied using the method of Szczytko and Stewart (1984).

Ova dissected from preserved gravid females were prepared for SEM study as described by Szczytko and Stewart (1979). Scanning electron micrographs of ova were made with an ISI Super III SEM.

Terminology used to describe antennal and cercal sensory structures follows Kapoor (1985); egg terminology follows Stark and Szczytko (unpub.)

RESULTS AND DISCUSSION
Cosumnoperla, NEW GENUS

Type species.—*Cosumnoperla hypocrena* Szczytko and Bottorff Generic Characters: Adult and nymphal mesosternal Y-ridge arms meet posterior corners of furcal pits; transverse band connects anterior corners of furcal pits (Fig. 7). Gills absent.

Male.—Tenth tergum entire with broad, elevated notched triangular process (Fig. 3). Supra-anal process small, bulbous and lightly sclerotized (Fig. 3). Paraprocts reduced and lightly sclerotized (Figs. 3, 5). Vesicle absent. Aedeagus membranous (Fig. 2).

Female.—Subgenital plate large with deep posteromedian notch (Fig. 4).

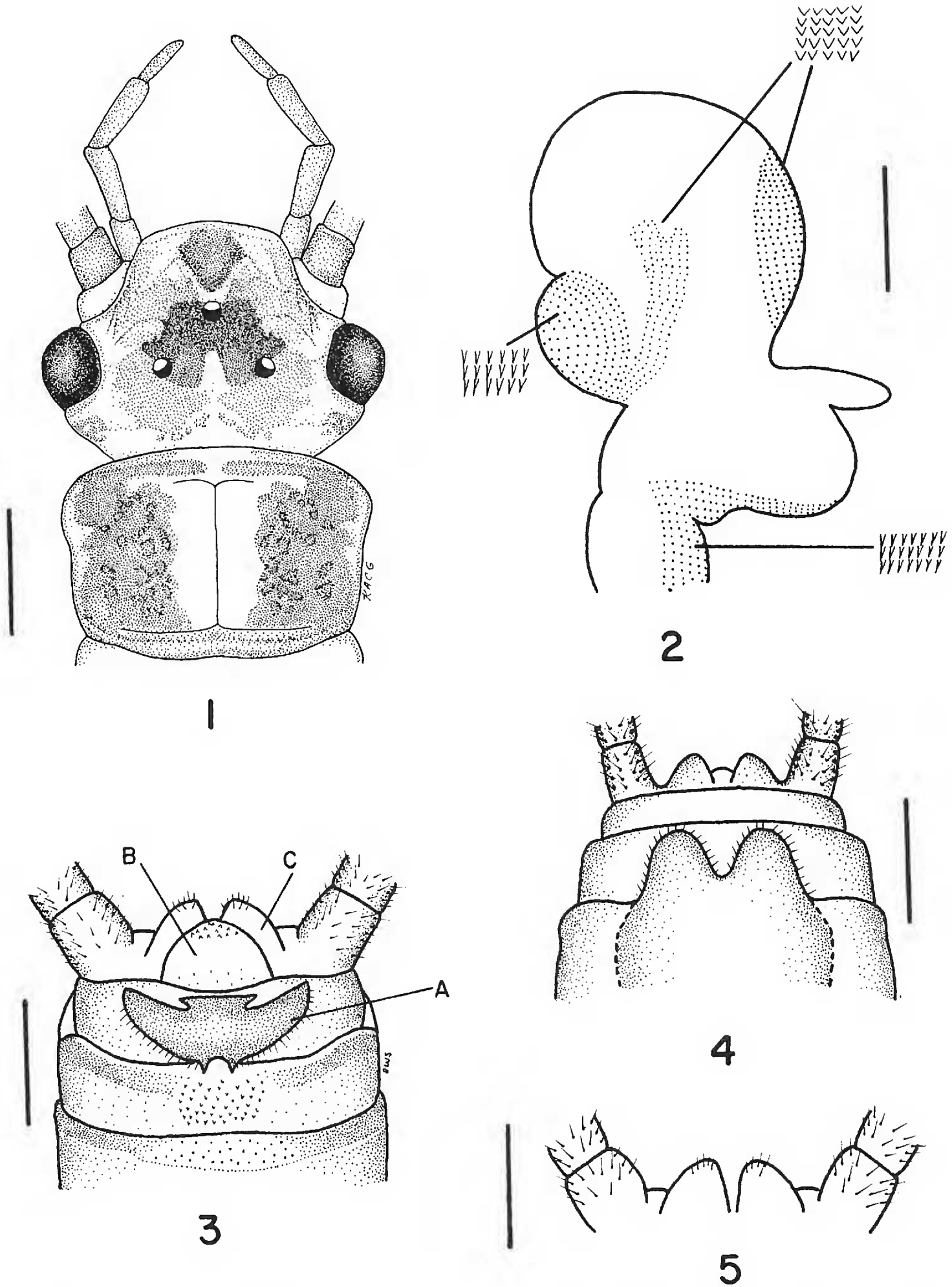
Ova.—Outline oblong, cross-section circular. Collar absent (Fig. 20).

Nymph.—Lacinia bidentate (Figs. 13, 14). Mandibles with 6 teeth, not deeply incised (Figs. 8, 9, 16, 18). Abdominal terga with 3 longitudinal dark stripes and 2 median and 6 lateral longitudinal rows of dots (Fig. 10).

Distribution.—This monotypic genus is known only from the Cosumnes River in the Sierra Nevada Mountains of northern California.

Cosumnoperla hypocrena, NEW SPECIES

Male.—Macropterous. Body length 11–13mm; forewing length 10–11mm. General body color light creamy yellow with dark brown markings on the head and thorax. Dorsum of head with wide dark brown patch connecting lateral and anterior ocelli, light, small inverted U-shaped spot extending midlength of interocellar area; lighter brown patches separated medially, extending from lateral ocelli to occiput, few scattered small spots in light area between light brown patches; light brown patches extending from dark brown ocellar patch to bases of antennae, thin U-shaped, light patch above anterior ocellus with dark brown median patch extending to frons (Fig. 1). Pronotum with median light stripe, disks medium brown, rugosities dark brown (Fig. 1). Meso- and metanota medium brown. Antennal flagella medium brown, pedicle light; surface of flagellar segments covered with long and short sensilla trichodea (Fig. 30) and sensilla companiformia (Fig. 24). Cerci light basally, progressively darker apically, cercal segments covered with long sensilla trichodea and with posterior whorl of short and 4 long posteroventral sensilla trichodea (Fig. 22). Maxillary and labial palpi dark brown. Wings medium smoky

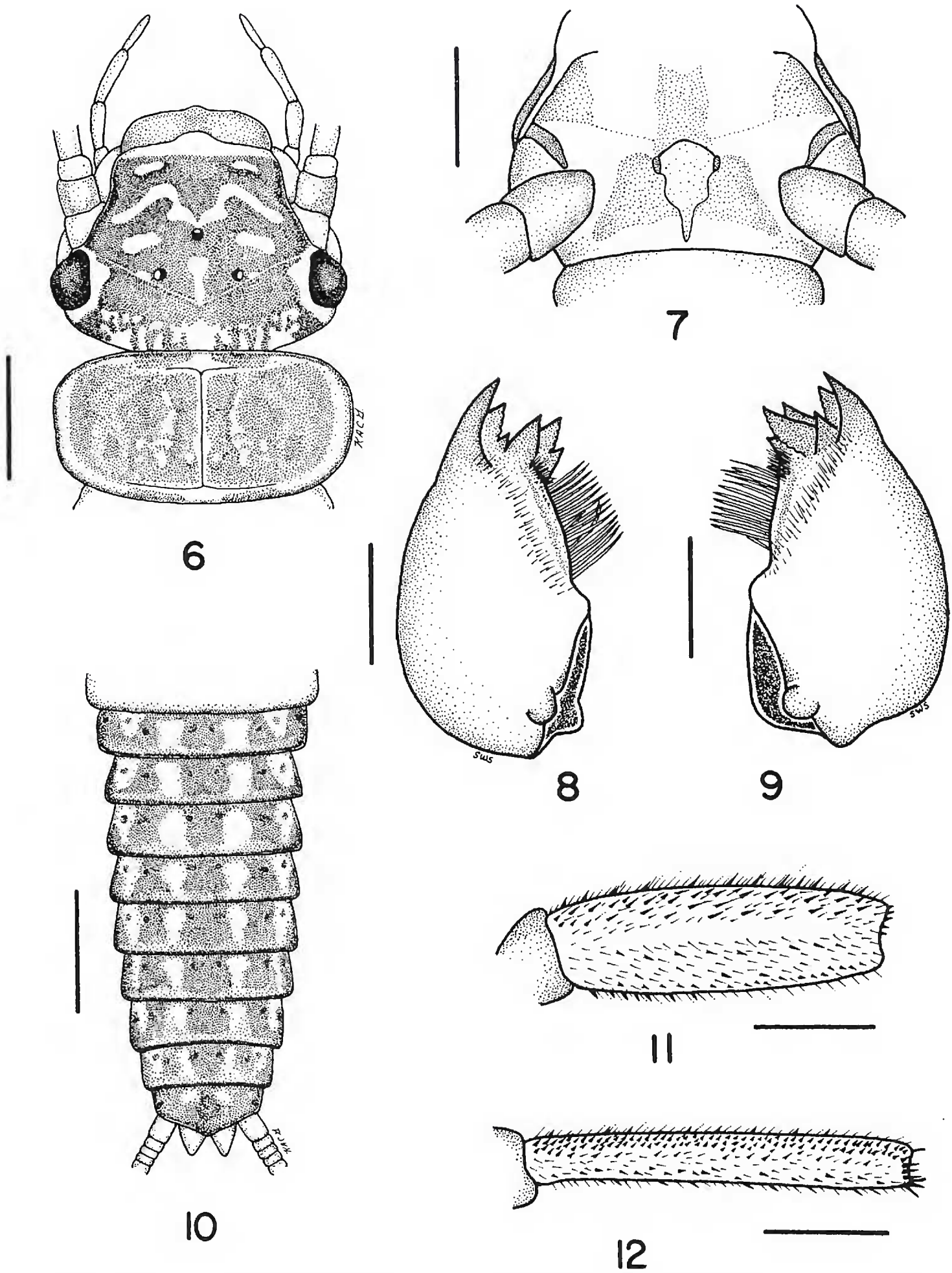


Figures 1-5. *Cosumnoperla hypocrena*. 1. Adult head and pronotum; line = 0.9mm. 2. Male aedeagus, lateral aspect; line = 0.5mm. 3. Male terminalia, dorsal aspect (A.-tenth tergal process, B.-supra-anal process, C.-paraprocts); line = 0.5mm. 4. Female terminalia, ventral aspect; line = 0.8mm. 5. Male paraprocts, dorsal aspect; line = 0.5mm.

brown with dark brown veins. Dorsal surface of femora dark brown, most of tibia and tarsi dark brown. Abdomen creamy yellow. Eighth tergum with posteromedian patch of short stout setae (Fig. 3). Ninth tergum with median patch of stout reddish brown spinulae (Fig. 3). Elevated triangular process of 10th tergum heavily sclerotized, darker than rest of tergum, highest at anterior margin with 2 sharply pointed anterior lobes, margins fringed with long fine setae, base depressed (Fig. 3). Supra-anal process with dark stout apical spinulae, basal area with scattered small, fine, light spinulae (Fig. 3). Paraprocts nearly flat, broadly triangular, positioned below supra-anal process (Figs. 3, 5). Aedeagus with large anteromedian and posteroventral lobes, small finger-like lobe above posteroventral lobe, apical section expanded into large balloon-like tip; posterior patch of small stout, golden brown spinulae above small finger-like lobe, patch of longer stout spinulae below large posteroventral lobe, patch of medium spinulae on large anteromedian lobe which grade into short stout spinulae laterally, patch of lateromedian small stout spinulae posterior to large anteromedian lobe (Fig. 2).

Female.—Macropterous. Body length 11–15mm; forewing length 11–14mm. Body coloration and external morphology similar to male. Subgenital plate broadly truncate extending to near posterior margin of 9th sternum, base extending to midlength of sternum 8 (Fig. 4).

Nymph.—Body length of mature nymph 10–13mm. General body coloration medium brown. Dorsum of head with distinct broad, light M-shaped band anterior to median ocellus; broad median brown patch connecting ocelli extending across head anteriorly to frons with light spots anterior to lateral ocelli and also anterior to light M-shaped band; interocellar area with irregular shaped light spot; irregular reticulate light patches posterior to occiput; frontoclypeus light (Fig. 6); occiput with irregular sinuous row of short spinulae. Dorsum of head and thorax with scattered fine black clothing hairs. Lacinia triangular with 4–5 long axillary setae between apical teeth; shoulder with 7–8 long stout spine-like setae below subapical tooth; row of 5–6 long finer marginal setae below shelf; 5–6 small fine marginal setae scattered to lacinal base; subapical tooth ca. $\frac{3}{4}$ length of apical tooth (Figs. 13, 14); teeth with fine striations (Fig. 17). Mandibles with median ventral row of long setae from base of outer tooth extending to near mandibular base; inner mandibular surface concave with row of long stout marginal setae; dorsal surface with median row of medium length setae from base of inner tooth to base of marginal setal row; brush of short stout, thick setae from base of inner teeth to marginal setal row (left mandible with thicker, longer setal brush) (Figs. 8, 9, 16, 18); inner tooth and subapical tooth with 2 rows of small, shallow crenulations (Fig. 14). Antennae light, distal margin of flagellar segments with thin and thick wall sensilla trichodea and coniform sensilla complexes consisting of 4–6 cuticular spines (Figs. 23, 25); conical poreless coeloconic pegs scattered on flagellar surface (Figs. 27, 29); pedicle surface covered with scattered thick-walled and thin-walled sensilla basiconica and distal margin with complete row of long, stout sensilla basiconica (Fig. 23); first flagellar segment with sparse median row of long sensilla basiconica (Fig. 23). Pronotum with light median stripe and lateral margins; disks light brown; rugosities light; margin completely fringed with short stout setae; occasional longer setae at posterior margins. Meso-metanota medium brown with irregular reticulate light areas. Thoracic and abdominal sterna with numerous chloride cells on integumental membranes (Fig. 28). Femora light brown with continuous row of long, fine dorsal setae and scattered



Figures 6-12. *Cosumnoperla hypocrena*. 6. Nymph head and pronotum; line = 1.0mm. 7. Nymph mesosternum; line = 0.7mm. 8. Nymph right mandible, ventral aspect; line = 0.3mm. 9. Nymph left mandible, ventral aspect; line = 0.3mm. 10. Nymph abdomen, dorsal aspect; line = 1.4mm. 11. Nymph right, hind femora, dorsal aspect; line = 0.7mm. 12. Nymph right, hind tibia, dorsal aspect; line = 0.7mm.

stout setae; dorsal $\frac{1}{3}$ of outer surface with numerous medium length, stout setae and numerous fine black setae (clothing hairs); thin light stripe void of setae below dorsal $\frac{1}{3}$; ventral $\frac{2}{3}$ with sparser medium length, stout setae and numerous fine black clothing hairs; no long ventral fringe; inner surface with few scattered medium length, stout setae (Figs. 11). Tibia with sparse dorsal fringe of long setae; ventral margin with fringe of medium length stout setae; outer surface covered with long black clothing hairs (Fig. 12). Abdominal terga with 2 noncontinuous light median, and 2 lateral longitudinal bands between dark median bands, usually enclosed by thin dark irregular anterior and posterior bands (may vary to some degree between individuals) (Fig. 10). Terga with posterior fringe of medium length stout setae and numerous scattered intercalary spinules (Fig. 19). Cerci light, segments with posterior whorl of short and several scattered long sensilla basiconica; longitudinal grooves at posterior margins (Fig. 26).

Ovum.—Length 0.8–0.9mm; width 0.4–0.5mm (fresh ova with living embryos are 0.6–0.7mm wide). Color light green. Chorion covered with irregular hexagonal follicle cell impressions (FCI's); FCI walls thick, raised; floor flat, irregularly shaped (quadrangular to hexagonal). Micropylar row subequatorial; orifices small without lips, set in floor of FCI's, some associated with FCI rosettes. Eclosion line absent (Figs. 20, 21).

Distribution.—This species is known only from the type locality.

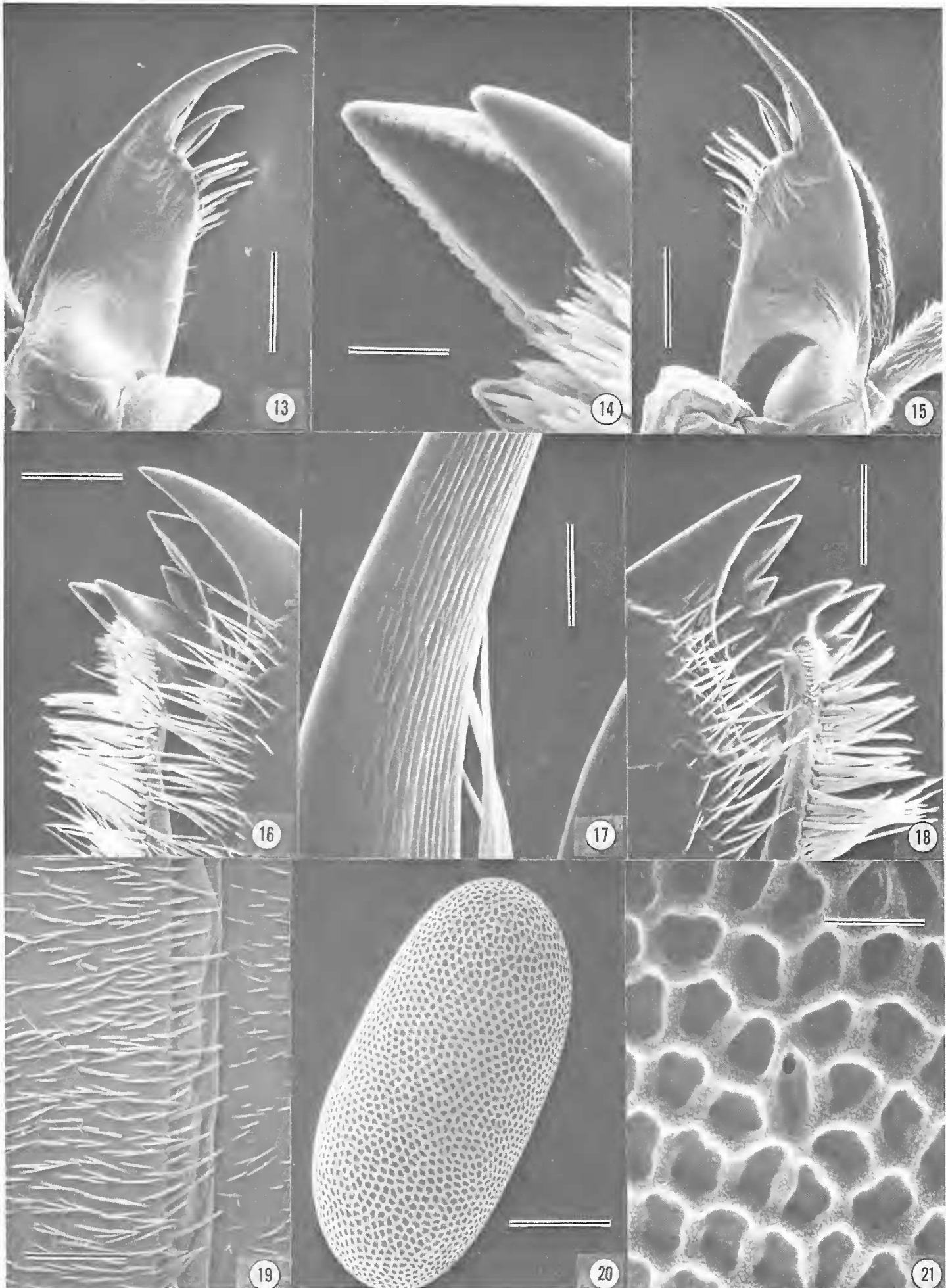
Material Examined.—USA. California. El Dorado Co., 5.8 km E. of Somerset, Unnamed trib., 500m upstream from Sweeneys Crossing Bridge on North Fork Cosumnes River, 28–V–1983, R. L. Bottorff (3 females), 4–VI–1983 (2 females), 24–VI–1983 (1 female), 11–V–1984 (6 nymphs, 3 males, 1 female), 27–V–18–VI–1984 (3 males, 2 females), 22–VI–1984 (1 female), 24–VI–1984 (1 female), 29–V–1985 (1 male, lab-reared), 22–VI–1985 (2 females, lab-reared), 24–VI–1985 (1 male, 7 females lab-reared).

Types.—Holotype male, allotype female and 1 paratype nymph from the above locality deposited in the U.S. National Museum, one male, one female and one nymph paratypes deposited in the Brigham Young University collection. Six male, 18 female and 4 nymph paratypes deposited in the collections of S. W. Szczytko and R. L. Bottorff.

Etymology.—The genus was named in honor of the Cosumnes River and a tribe of Miwok Indians in central California. The species name is derived from the "hypocrenon" (head water tributary stream) of Illies and Botosaneanu's (1963) river classification scheme, as a habitat descriptor of this species.

Biological Notes.—The type locality is shallow spring water flowing over moss covered rocks and is heavily shaded. The stream only flows about 7 months (November–June) each year, then is dry in summer and autumn. Intensive collecting along the main Cosumnes River, its North Fork, and a few smaller tributaries, involving slit traps (Kuusela and Pulkkinen, 1978) and searching methods, as part of a larger ecological study of all Cosumnes River stoneflies, failed to produce any additional specimens of this species. The restricted habitat preference of *C. hypocrena* has, most likely, precluded previous collection by other workers.

Emergence begins the first week in May and extends through late June, or until the stream dries up. Males emerge before females and continue into early June. Females begin emerging in late May.



Figures 13–21. *Cosumnoperla hypocrena*. 13. Nymph right, lacina, ventral aspect; line = 263 microns. 14. Detail of inner left mandibular tooth, ventral aspect; line = 26 microns. 15. Nymph left lacina, ventral aspect; line = 263 microns. 16. Detail of nymph left mandibular teeth, ventral aspect; line = 132 microns. 17. Detail of right, apical lacinial tooth, ventral aspect; line = 4 microns. 18. Detail of nymph right mandibular teeth, ventral aspect; line = 132 microns. 19. Nymph second and third abdominal terga, dorsal aspect; line = 208 microns. 20. Ova; line = 208 microns. 21. Detail of ova chorion and micropyle; line = 25 microns.

This species has the largest egg of any described Isoperlinae species. Most *Isoperla* species have eggs which range from 0.21–0.45 mm-length and 0.13–0.36 mm-width (Jop and Szczytko, 1984; Nelson and Kondratieff, 1983; Szczytko and Stewart, 1976, 1978, 1979 and 1984). The egg of *Clioperla clio* (Newman) is 0.42 mm-length and 0.31 mm-width (Szczytko and Stewart, 1981) and the egg of *Calliperla luctuosa* (Banks) is 0.36 mm-length and 0.28 mm-width (Szczytko and Stewart 1984). The egg is also fairly atypical of most Isoperlinae species in that the collar and eclosion line are absent, although *C. luctuosa* also has an egg with no collar or eclosion line (Szczytko and Stewart, 1984).

Females of this species have the lowest fecundity of any reported Isoperlinae species. Eggs from 9 gravid females with abdomens extended with well developed eggs, were counted and mean fecundity was 39 with a range of 19–58 eggs. Harper (1973) reported mean fecundities of 441 (range–113–788) for *C. clio*, 95 (range–23–190) for *Isoperla transmarina* (Newman), 177 (range–17–392) for *I. cotta* Ricker and 146 (range–18–277) for *I. frisoni* Frison. These data were generated from lab-reared and field-collected specimens and the determined means are most likely low, due to field oviposition. The low fecundity of *C. hypocrena* is probably related to the large size of the egg and the physical restriction of space within the female abdomen.

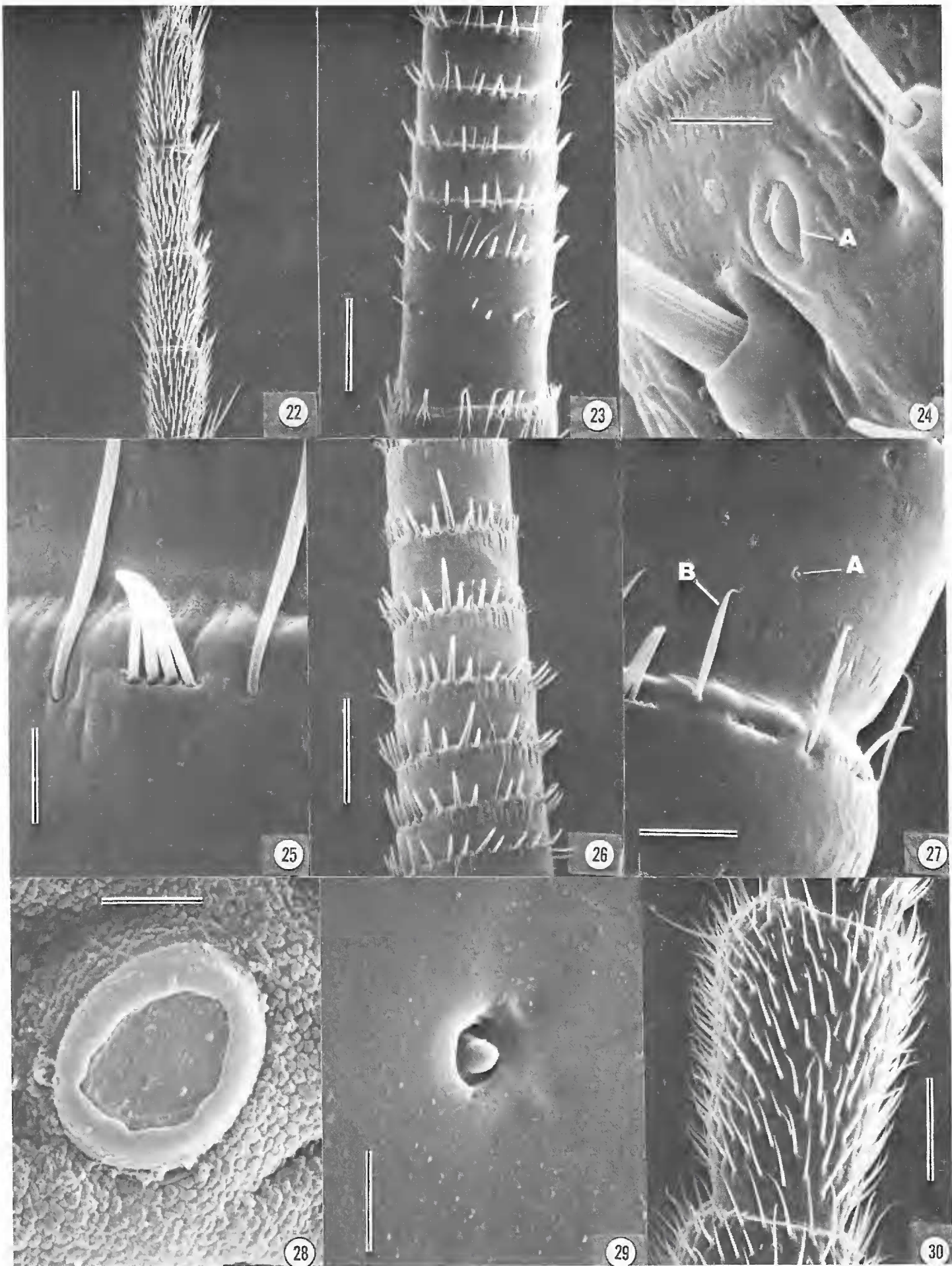
Several nymphs were dissected and the gut contents examined for food items. Two nymphs had several culicid larvae, as well as diatoms in the hind gut, indicating that this species is probably omnivorous in late instars.

Diagnosis.—*Cosumnoperla* and *Calliperla* share the following synapomorphies; mostly membranous male supra-anal process, reduced male paraprocts not recurved to level of 10th tergum and large oblong ova without collar and eclosion line. *Cosumnoperla* males can be distinguished from *Calliperla* by aedeagus lacking tubular, striated apical portion, vesicle absent from 8th sternum, supra-anal process without finger-like apical section, 10th tergal process elevated and triangular and head pattern with interocellar light spot. Females can be separated by the large, truncated, deeply notched subgenital plate and light interocellar spot of the head pattern. Nymphs can be differentiated by the longer subapical lacinal tooth, 4–5 axillary setae and $\frac{7}{8}$ long stout spine-like setae on shelf, cercal segments without long dorsal setae, transverse ridge connecting anterior corners of mesosternal furcal pits, dark lateral abdominal bands without light spots and head pattern with light interocellar spot. Ova can be separated by larger size, FCI floors not punctate, micropyles positioned in FCI floors and some associated with FCI rosettes.

CONCLUSIONS

Cosumnoperla is apparently most closely related to *Calliperla*. This relationship is supported by synapomorphies exhibited in males, females and ova discussed above. *Cosumnoperla* also shares characters with *Mesoperlina* such as modified male 10th tergum, vesicle absent, distinct spinule patches on male 9th tergum, presence of supra-anal process and transverse ridge connecting anterior corners of mesosternal furcal pits. The phylogenetic relationships of *Cosumnoperla* and other Nearctic Isoperlinae genera with *Mesoperlina* and *Kaszabia* are suspect at this time due to the paucity of material available for critical study of all life stages.

Cosumnoperla shares characters with other Isoperlinae genera such as absence of gills and mesosternal Y-ridge attached to posterior corners of furcal pits, but also



Figures 22-30. *Cosumnoperla hypocrena*. 22. Adult cerci; line = 250 microns. 23. Nymph antennae, basal segments; line = 132 microns. 24. Detailed adult antennal segment (A.-sensilla companiformia); line = 8 microns. 25. Detailed adult antennal segment with coniform sensilla complex and cuticular spines; line = 18 microns. 26. Nymph cerci, ventral aspect; line = 125 microns. 27. Nymph antennal segment (A.-conical poreless coeloconic peg, B.-thick-walled sensilla basiconica); line = 26 microns. 28. Nymph chloride cell; line = 4 microns. 29. Detailed nymph antennal segment with conical, poreless coeloconic peg; line = 4 microns. 30. Adult antennal segment; line = 63 microns.

shares characters such as male supra-anal and 10th tergal processes, with some Perlodinae.

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